Food web structure analysis using stable isotopes

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Food web structure describes

- how material is passed through the system
- how pelagic and benthic systems are linked (bottom-up)

Stable isotopes

- can be used as water mass tracers
- can be used as food web indicators:

  food sources and trophic levels
- food web marker with reduced "noise"

Hypothesis

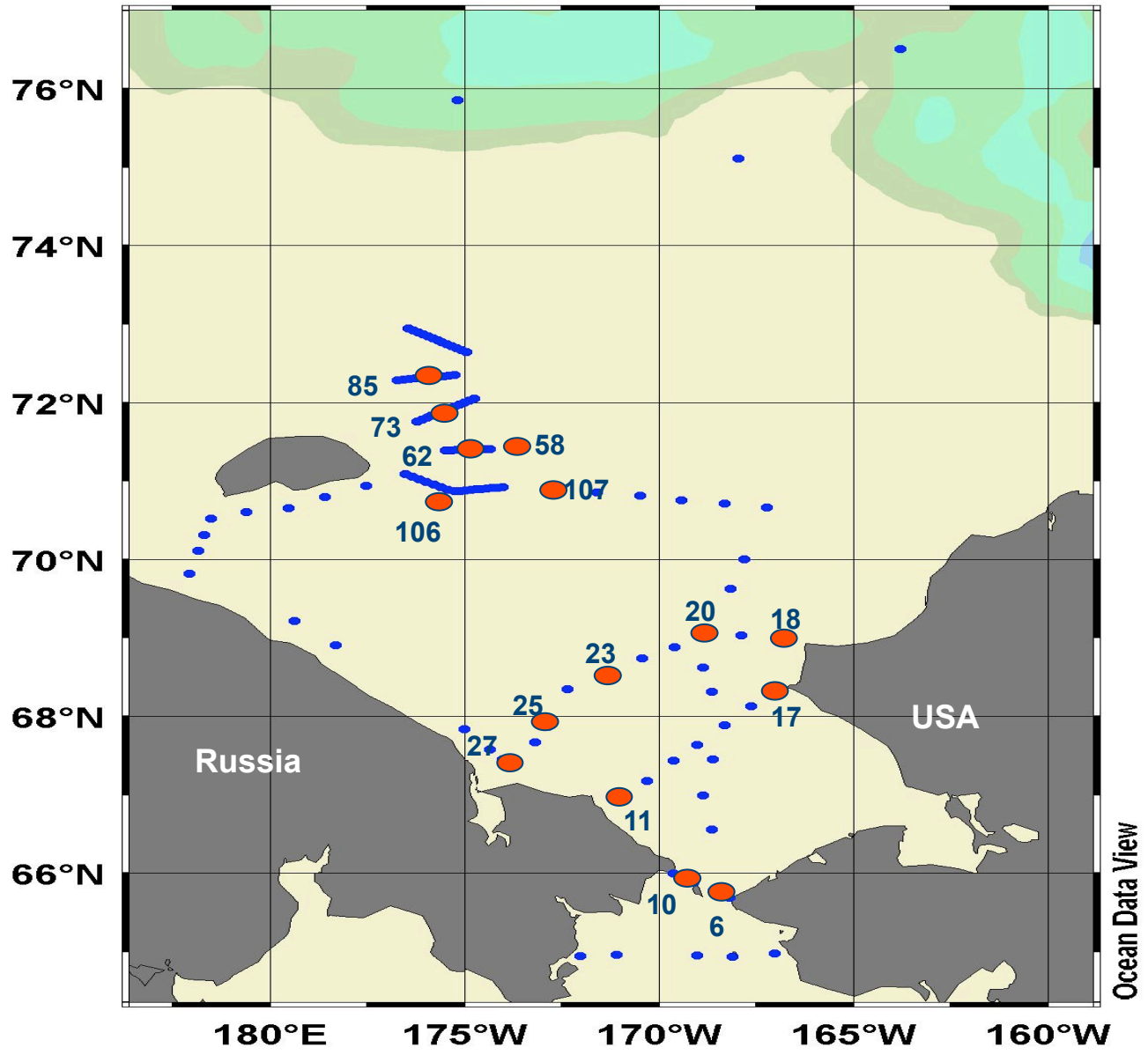
Isotopic patterns and food webs are characteristic of the water mass in which the community occurs

Stable isotopes in food web context

- Naturally occurring stable isotopes of carbon and nitrogen
- ^{13} C and ^{15} N
- Occur in small but quantifiable amounts
- Are incorporated in biological processes
- Stepwise enrichment with trophic levels:

  ~1‰ for $\delta^{13}C$, ~3.5% for $\delta^{15}N$
- Integrate over time (~months)
- Carbon isotopes indicate food source
- Nitrogen isotopes indicate trophic level

Stations sampled for food web analysis

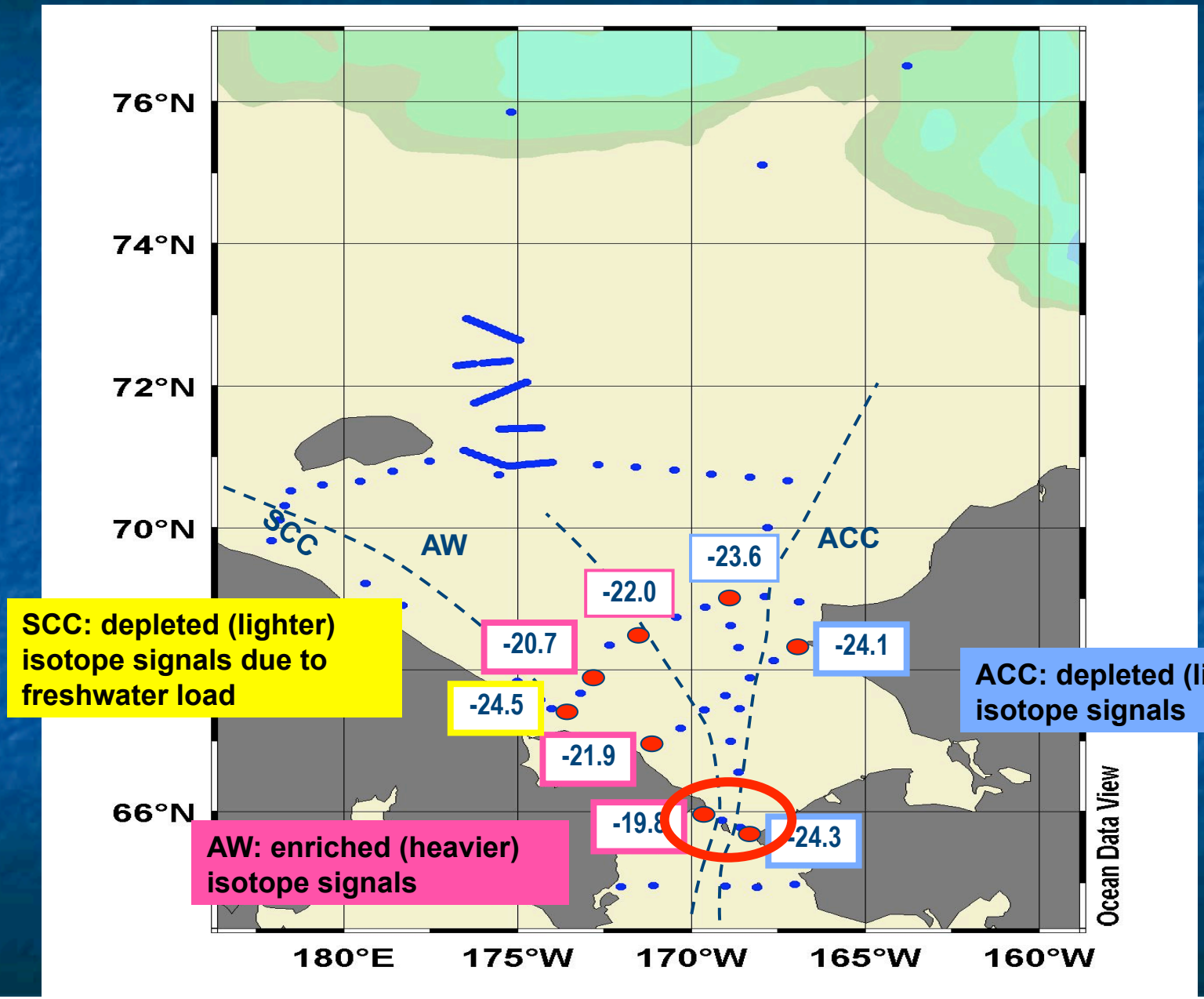


Sample processing

~2500 samples collected

~1500 samples analyzed

$\delta^{13}C$ values for particulate organic matter (POM)

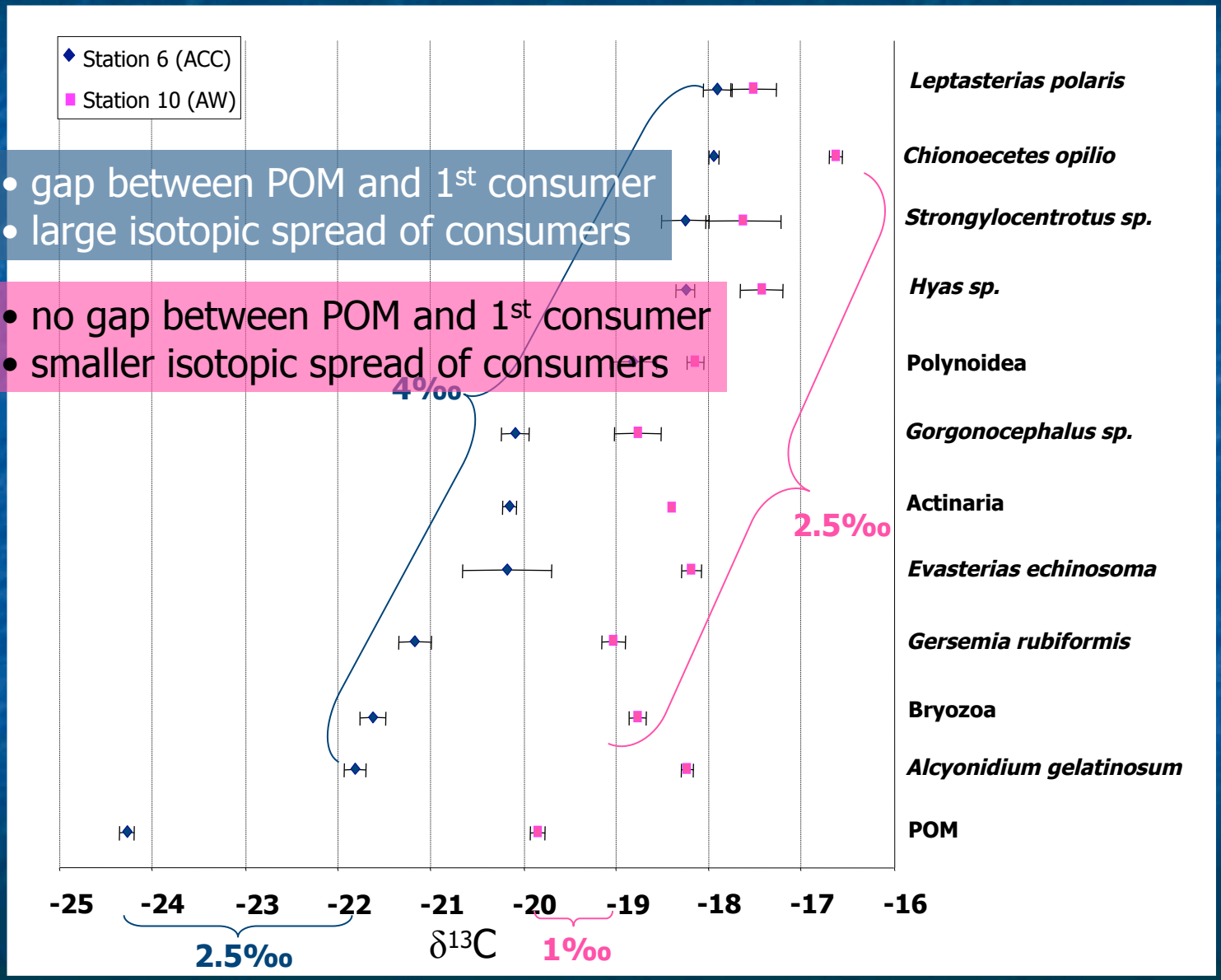


SCC: depleted (lighter) isotope signals due to freshwater load

AW: enriched (heavier) isotope signals

ACC: depleted (lighter) isotope signals

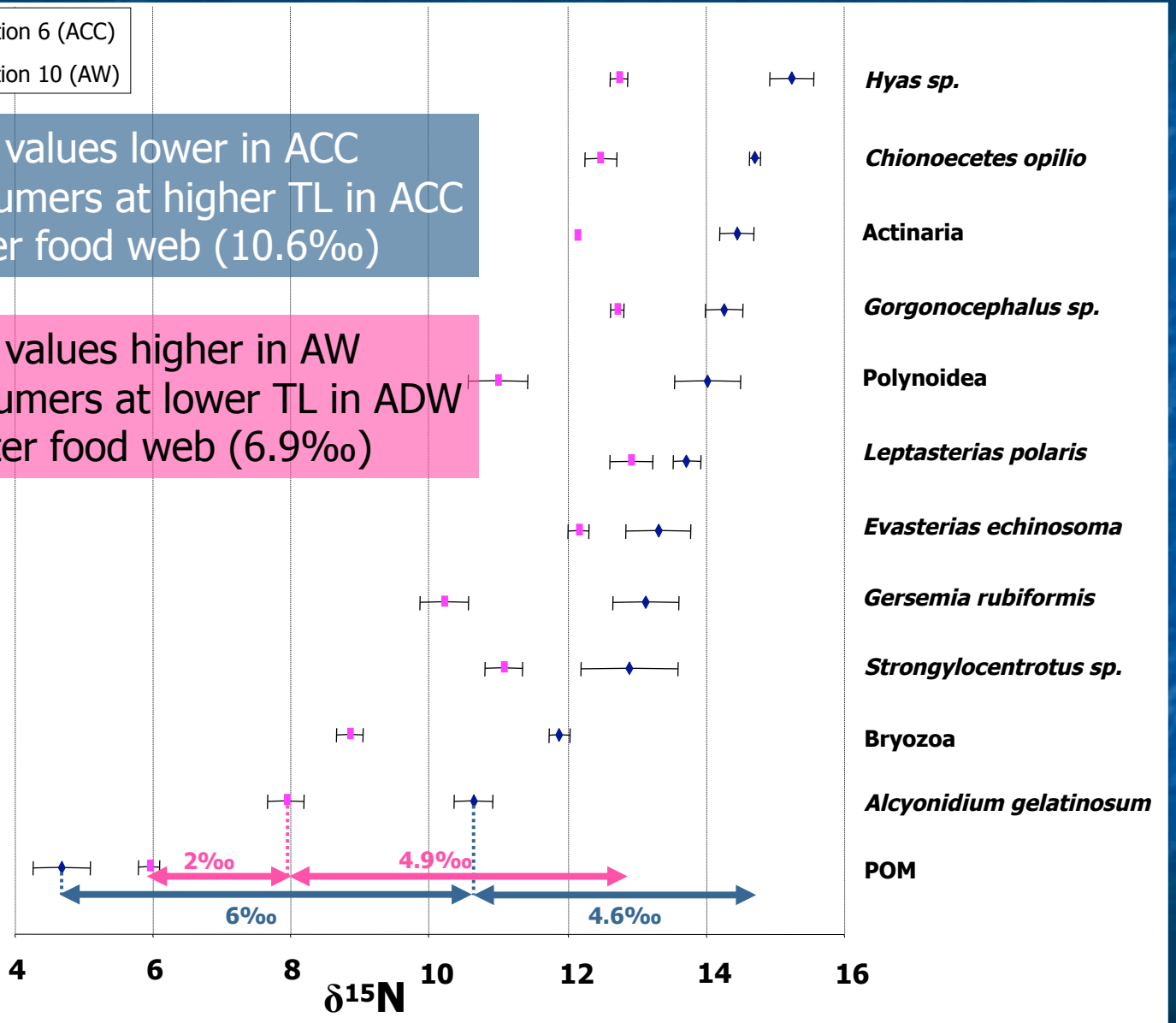
Carbon flux in benthic food web: $\delta^{13}C$



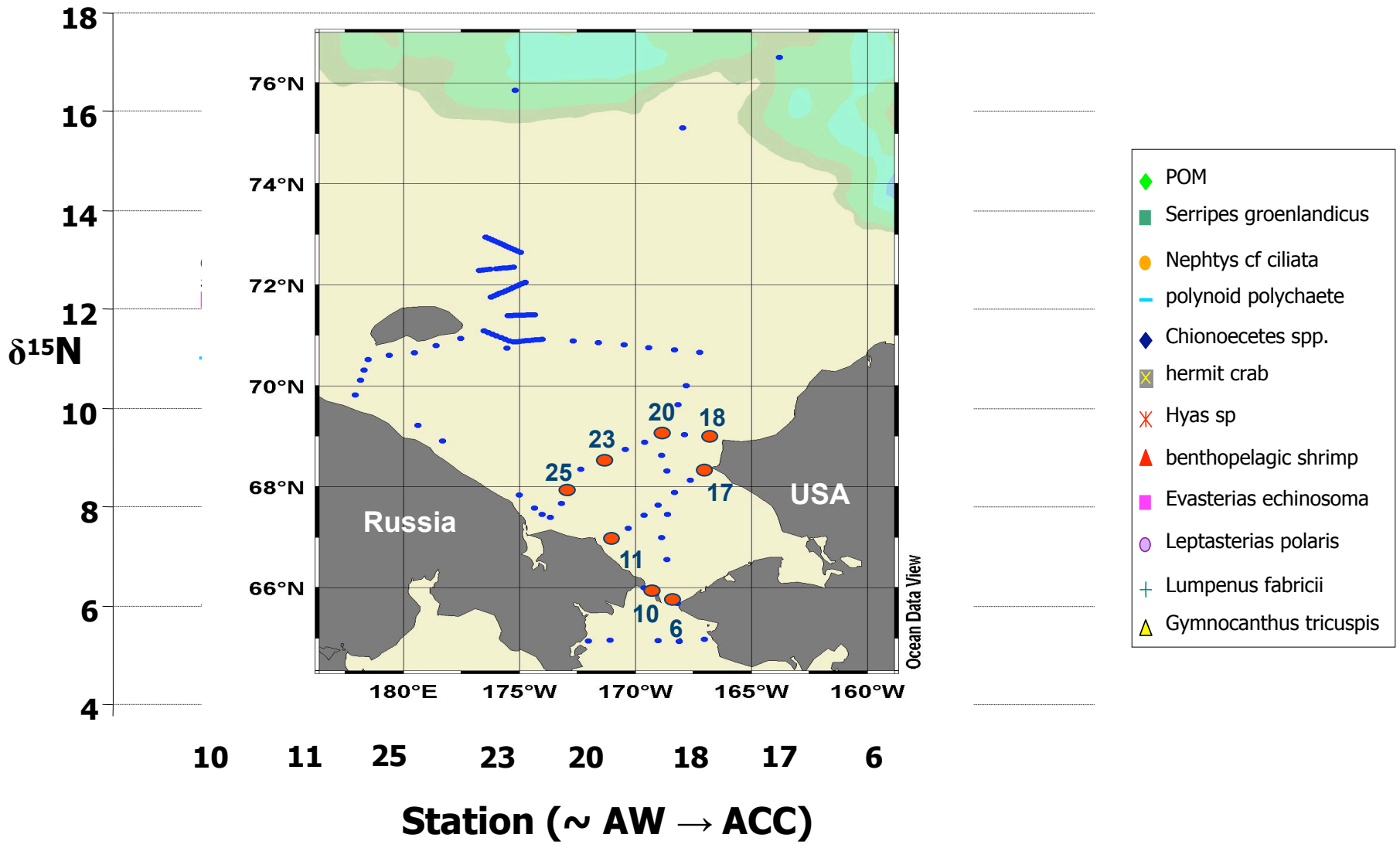
Trophic levels in benthic food web: $\delta^{15}N$

- POM values lower in ACC
- consumers at higher TL in ACC
- longer food web (10.6‰)

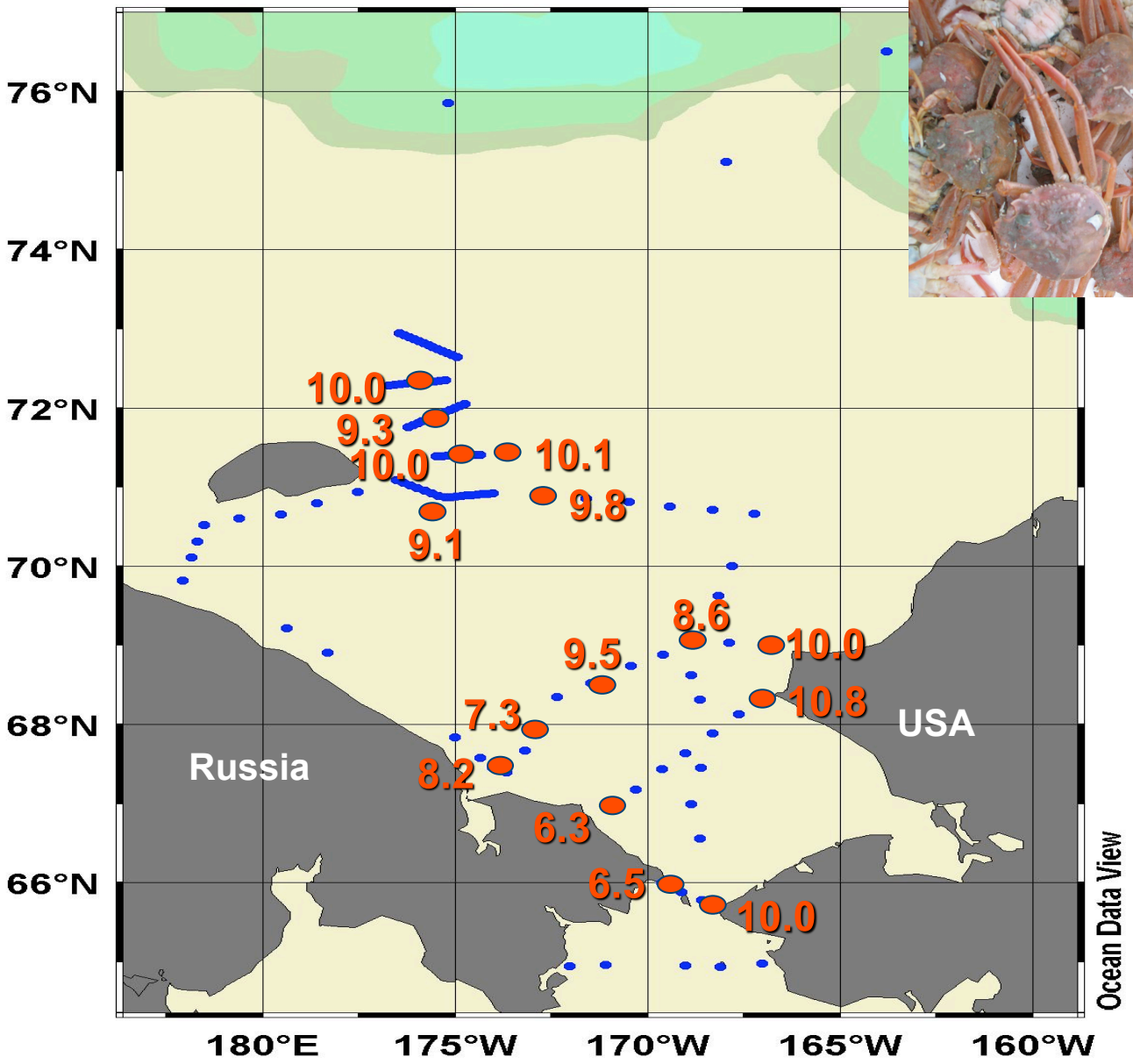
- POM values higher in AW
- consumers at lower TL in ADW
- shorter food web (6.9‰)



Trophic position of species by station

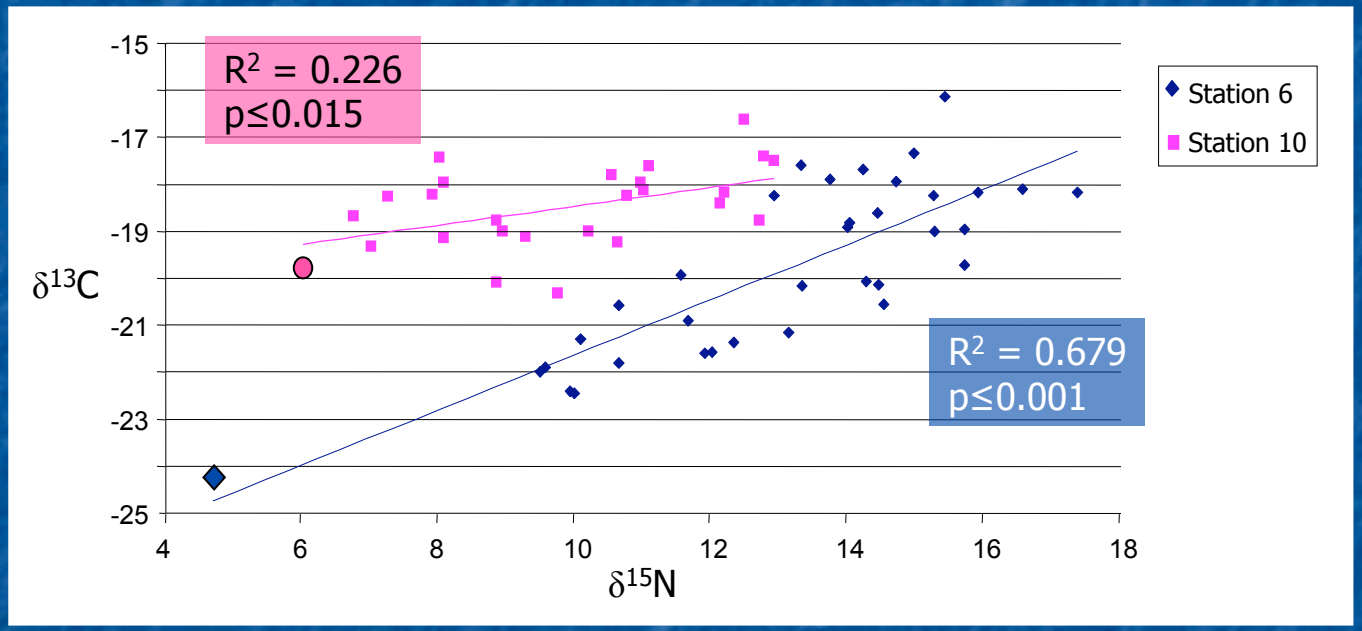


Food web length between POM and *Chionoecetes opilio*



Discontinuous food web in ACC conditions - possible explanations -

- Analytical error of measuring POM source
- Other carbon source than POM, e.g. ice algae, terrestrial material



- Intermediate consumers not considered, e.g. pelagic fauna

Emerging Hypotheses

Primary production in ACC system passes through pelagic food web before reaching seafloor, resulting in refractory material (enriched isotope ratios) for benthos
=> Loose coupling to benthos

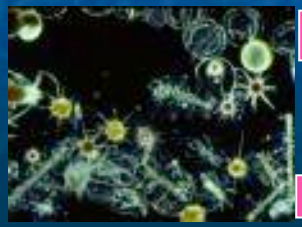
ACC




POM **plankton gazers** **plankton predators** **benthos**

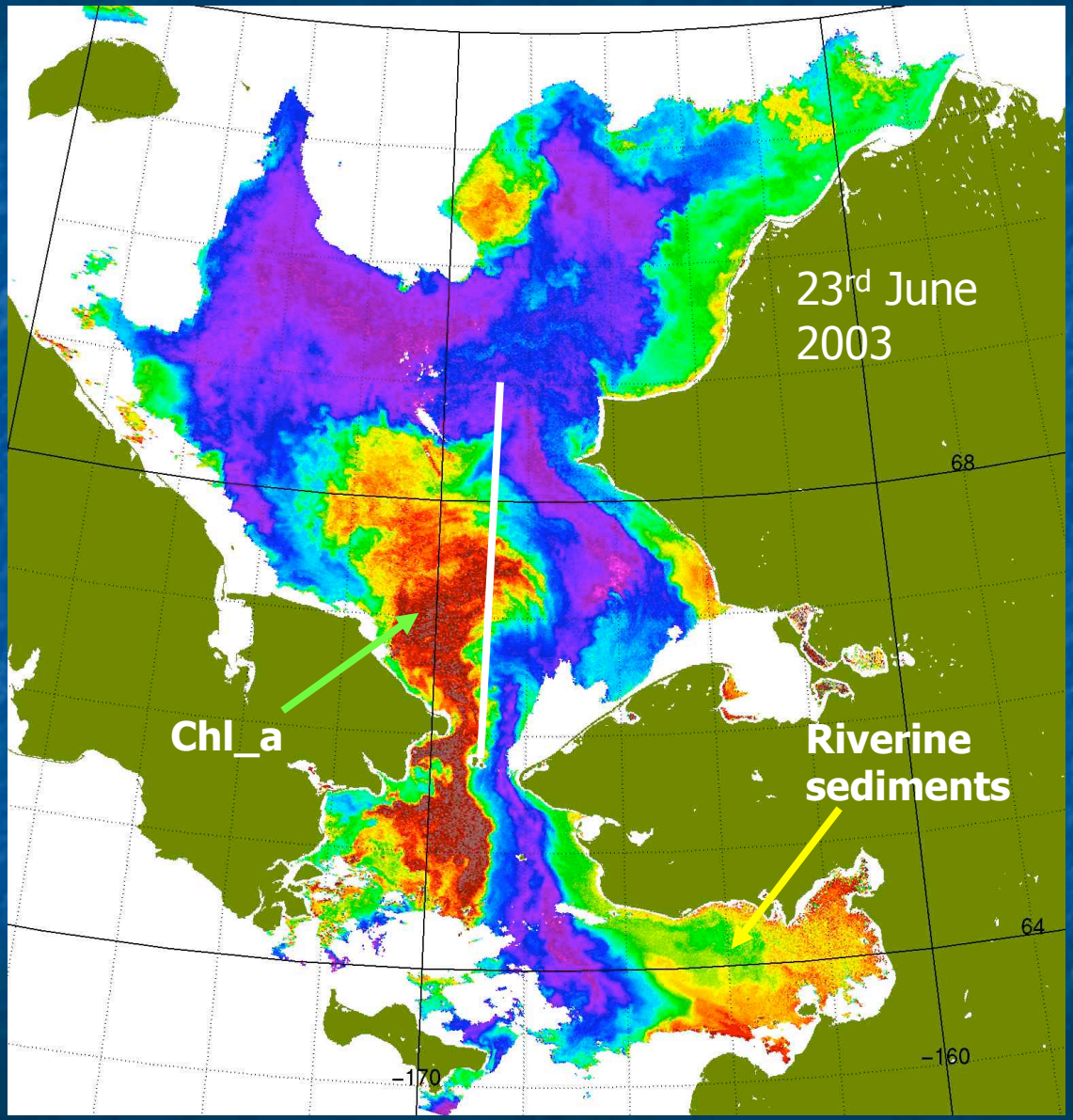
Significant portion of primary production in ADW system settles out on seafloor before consumed by zooplankton; labile material (less enriched ratios) for benthos
=> Tight coupling to benthos

ADW

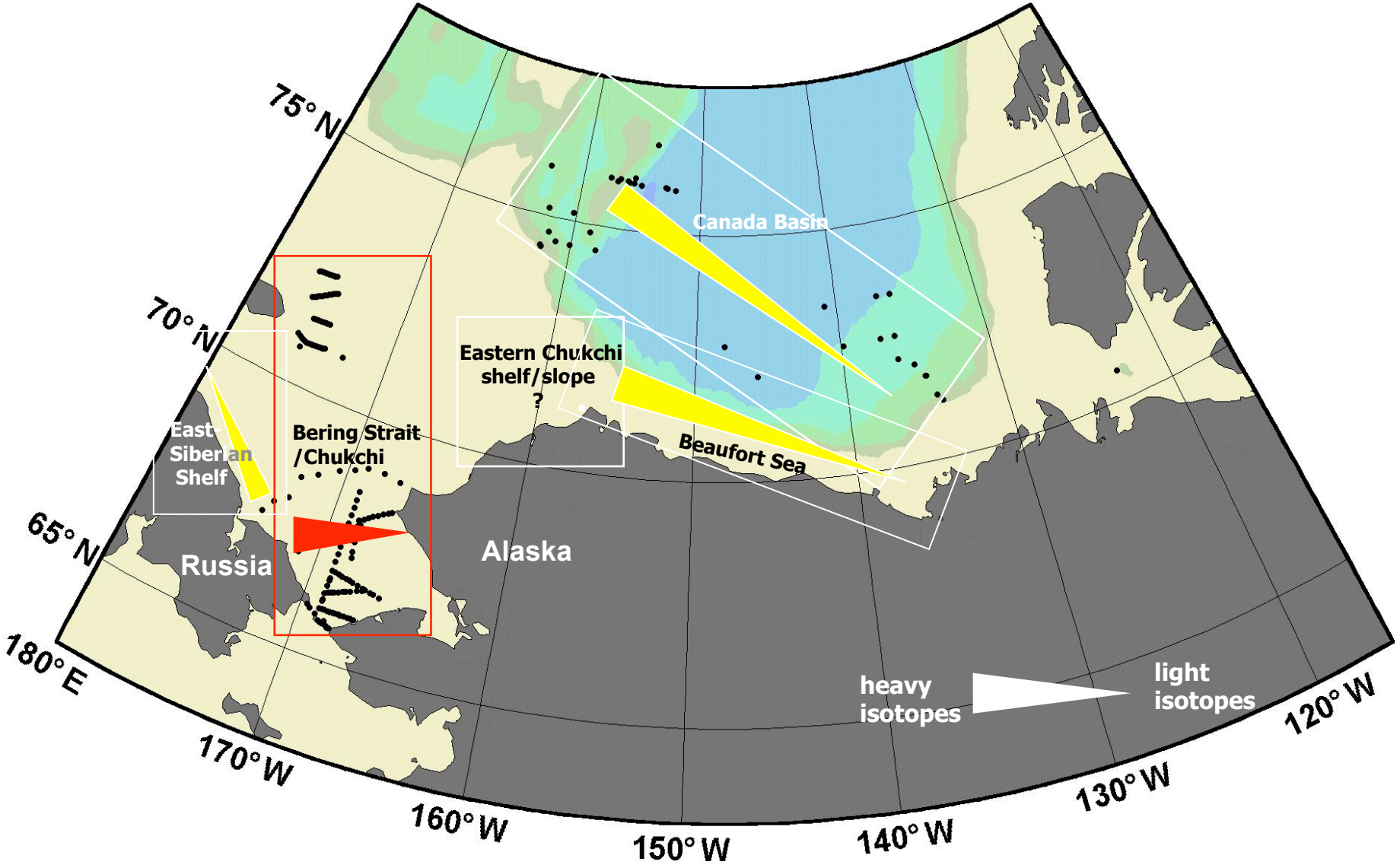



POM **plankton gazers** **plankton predators** **benthos**

Chlorophyll a distribution (SeaWifs Staellite)



Comparison with other regions



Conclusions

- Isotopic differences ($\delta^{13}C$) in water masses (POM)
- Gap between POM and first benthic consumer in ACC but not in AW conditions
- Same species in benthic community feed on higher trophic level in ACC water than in AW water
- Tighter coupling between POM and benthos in AW than in ACC
- Zooplankton probably major role in organic matter transfer in ACC, while direct POM deposit in AW

Acknowledgements

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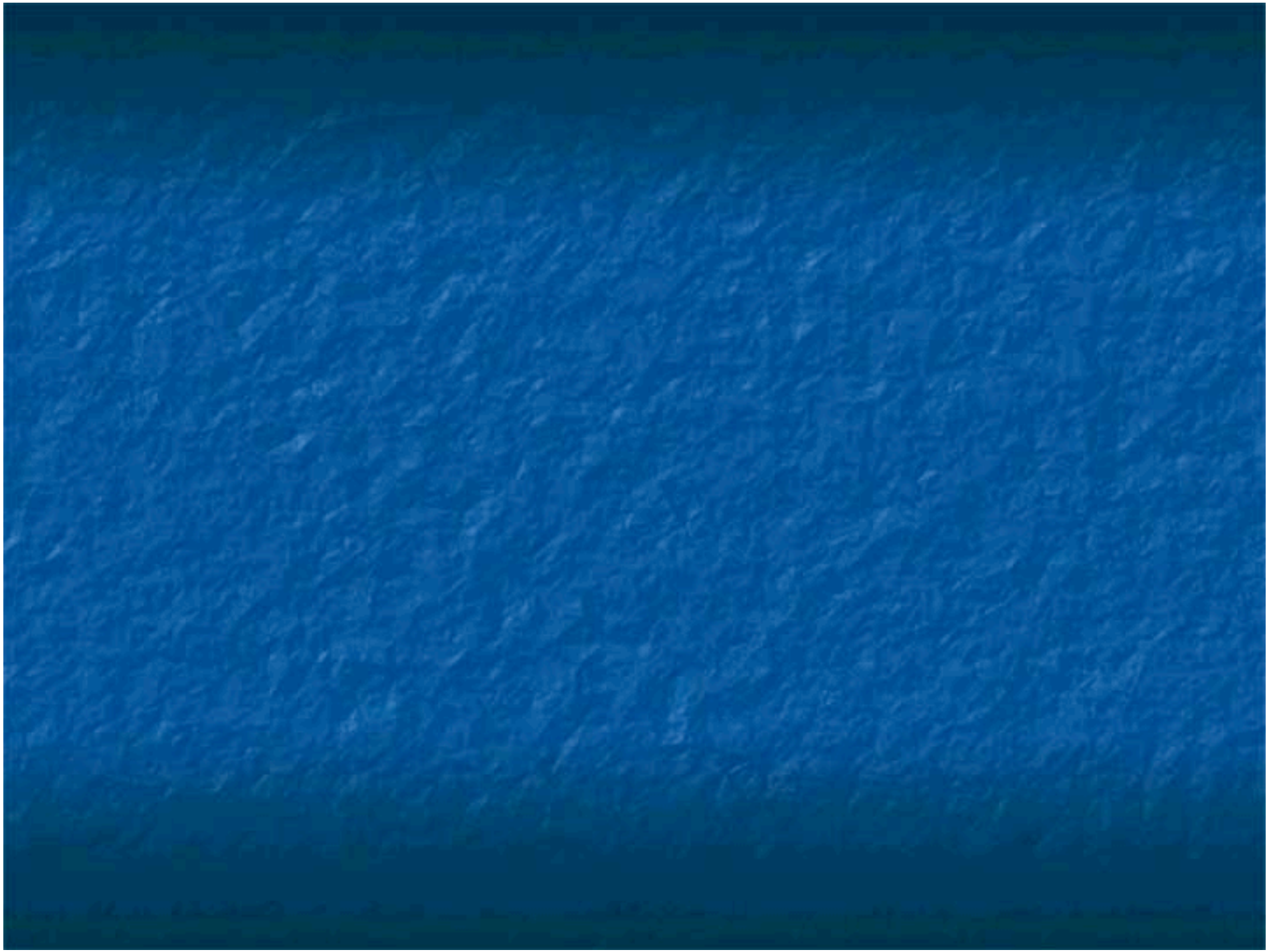
- Taxonomists: Ken Coyle, Igor Smirnov



Coupling to carbon source of species by stations